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U1S S1915

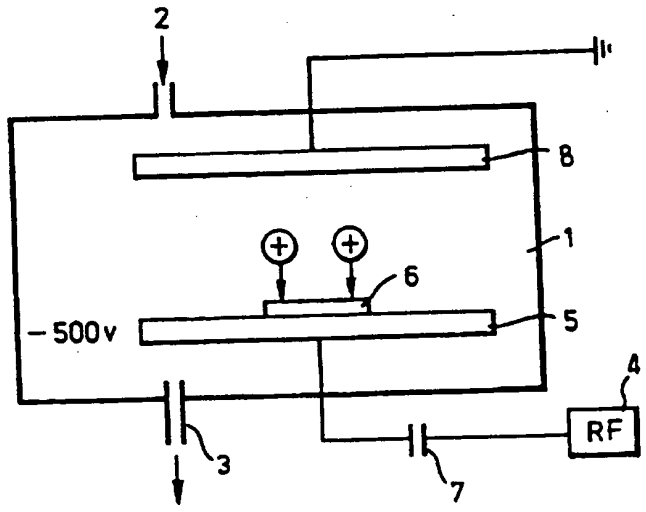
(56) Documents Cited

GB 2291652 A	GB 2270326 A	GB 2194556 A
EP 0686708 A1	EP 0536664 A1	EP 0448227 A1
US 5312778 A	US 5120680 A	US 5052339 A
US 4681653 A	US 4060660 A	

(58) Field of Search
UK CL (Edition O) C7F FHB FHE FHX
INT CL[6] C23C 16/50
Online: WPI, CLAIMS

(54) Plasma enhanced chemical vapour deposition of a layer

(57) A layer which is suitable for use in a planar waveguide optical circuit is formed on a substrate by plasma enhanced chemical vapour deposition, the process being carried out in a chamber having two electrodes. One of the electrodes carries the substrate and is energised with an electrical signal at a radio frequency through a capacitor. The other electrode is held at ground potential. The substrate is maintained electrically negative with respect to earth (50 - 500 volts). Silicon and germanium compounds with hydrogen ; or silicon, germanium, phosphorus and boron compounds with hydrogen are fed to the chamber with nitrous oxide.



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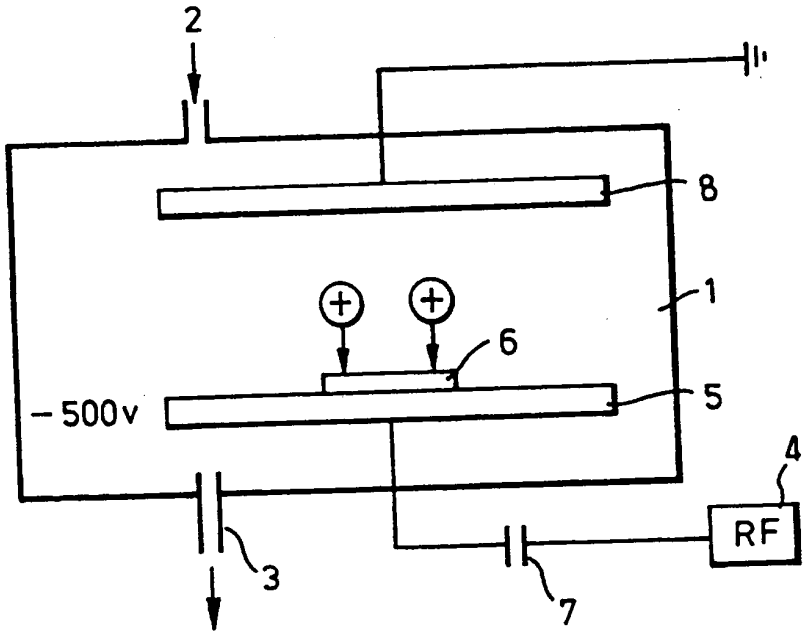
At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.


2
11
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PLASMA ENHANCED CHEMICAL VAPOUR DEPOSITION OF A LAYER

The present invention concerns the production of a layer, which is suitable for use as the core of a planar waveguide optical circuit using plasma enhanced chemical vapour deposition (PECVD). The production of a silicon oxide layer is described, as an example, although layers of other materials may be deposited, and the method to be described may be used for the production of layers which are suitable for other applications than planar waveguides devices.

Normally a deposit of silicon oxide or other materials, requires extensive annealing and densification of the layer deposited, the latter serving to expel hydrogen, water or hydrides, and then the compaction of the newly deposited layer to render it suitable for use in a planar waveguide. An arrangement to be described below seeks to reduce the typical requirement for annealing and densification, at least in part.

In the arrangement to be described below there is disclosed the use of an r.f. source between the electrodes of a plasma chamber, the electrode associated with a target substrate being energized through a capacitor, and the other electrode being directly earthed. It has previously been proposed to provide the energisation, for a plasma used in an enhanced chemical vapour deposition (PECVD) process, live, through a capacitor, to the electrode which is opposite to that supporting the substrate arranged to receive the deposit, with the aim, it is believed, of providing a more stable layer. By means of the arrangement to be described below, as an example, a more desirable layer is obtained, probably as a result of the bombardment of the layer by positive ions derived from the plasma discharge.

An electrode carrying a substrate, e.g. a silicon single crystal substrate and a buffer SiO_2, is made alternately positive and negative, relative to an earthed, electrode in the arrangement to be described, so that the more mobile electrons travel in greater quantities during a half cycle of one polarity to the live electrode than do the less mobile positive ions during a half cycle of other polarity of an applied r.f. signal. Thus the live electrode may acquire a negative charge of, for example some -500 volts. This it is believed adds to the bombardment energy by which the positive ions originating from the plasma materials impact the target substrate. The resulting deposited layer of germania doped SiO_2 is made more dense to a considerable extent.

An arrangement illustrative of the invention will now be described, by way of example, with reference to the single figure of the accompanying drawing which shows diagrammatically parts of a PECVD chamber.

Referring to the drawing, there is shown a plasma discharge chamber 1 which has an inlet 2 for precursor materials such as silane, nitrous oxide, germane, diborane, phosphine or other sources of silica, boron phosphorus or germanium doping, and an outlet 3 for pumping-out spent or exhaust materials. A source 4 of power in the radio frequency band which may, for example, be between 50 kHz and 13.5 MHz, is applied to an electrode 5 carrying a substrate 6 with a buffer layer for receiving a core layer deposit for use in a planar waveguide. The r.f. power is applied to the electrode 5 through a capacitor 7 which is able to withstand several hundred direct volts and to pass the r.f. power. A second electrode 8 is earthed. Upon the initiation of a plasma discharge between the electrodes 5 and 8 through the ionized precursor material, a germanium doped silicon oxide layer is formed on the substrate 6. The silicon oxide layer formed in this way is in a very satisfactorily impacted form, and has a very satisfactorily repeatable, or selectable, refractive index, which is most important in precursor wave guide work, particularly for interfacing with fibre optics or wavelength division multiplexing, which involves closely controlled differences between μ's of neighbouring

layers. The negative voltage developed at the live electrode 5 may be between 50-500 volts.

It will be understood that, although the invention has been illustrated, by way of example, with reference to one particular arrangement, variations and modifications thereof, as well as other embodiments may be made within the scope of the protection sought.

For example, although the method has been described with reference to the production of a layer which is suitable for use in a waveguide, a layer produced by the method may have other applications, and the layer may be other than a silicon oxide layer.

CLAIMS

1. A method of depositing a layer by PECVD which layer is to form part of an optical waveguide, wherein the substrate is maintained electrically negative with respect to ground.

2. A method of depositing a layer which is suitable for use in a planar waveguide optical circuit and which is carried out in a chamber having two electrodes using plasma enhanced chemical vapour deposition, including the step of energising an electrode associated with a substrate for the layer through a capacitor by means of an electrical signal at a radio frequency, the second electrode being held at ground potential.

3. A method as claimed in claim 1 or 2 wherein silicon and germanium compounds with hydrogen, or silicon, germanium phosphorus and boron compounds with hydrogen, are fed to the chamber with nitrous oxide.

4. A method as claimed in either claim 1, 2 or claim 3 wherein the r.f. source provides a signal at a frequency between 50 kHz and 13.5 MHz.

5. A method as claimed in any one of the preceding claims wherein a voltage between approximately 50-500 volts negative is developed during operation at the electrode to which the r.f. signal is capacitively fed with respect to the second electrode.

6. A method as claimed in any one of the preceding claims wherein the substrate includes silicon or quartz.

7. A method as claimed in claim 1 substantially as described herein with reference to the single figure of the accompanying drawing.

8. A layer deposited on a substrate by the method of any one of the preceding claims.

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Application No: GB 9608565.9 **Examiner:** Peter Beddoe
Claims searched: 1-8 **Date of search:** 12 June 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): C7F (FHB,FHE,FHX)

Int Cl (Ed.6): C23C 16/50

Other: Online: WPI, CLAIMS

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2291652 A	(BARR) See esp page 5 line 10 - page 6 line 20 & Fig 1	1,2
X	GB 2270326 A	(KOBE) See esp page 2 line 30 - page 5 line 22	1
X	GB 2194556 A	(SPECIAL) See esp page 2 lines 8 - 43 & Fig 1	1
X	EP 0686708 A1	(OHMI) See esp col 5 line41 - col 8 line 56 & Fig 1	1,2
X	EP 0678895 A1	(CANON) See esp pages 4-6 & Fig 2	1,2
X	EP 0536664 A1	(SUMITOMO) See esp page lines 42-49 & Fig 2	1,2
X	EP 0448227 A1	(NGK) See esp page 3 lines 7-11 & Fig 1	1,2
X	US 5312778	(APPLIED) See esp col 4 line 40 - col 5 line 64 & Fig 1	1,2
X	US 5120680	(AT&T) See esp col 3 line 14 - col 4 line 54 & Fig 1	1,2
X	US 5052339	(AIR) See esp col 6 lines 30-49 & Fig 1	1,2

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

The Patent Office

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Application No: GB 9608565.9 **Examiner:** Peter Beddoe
Claims searched: 1-8 **Date of search:** 12 June 1996

Category	Identity of document and relevant passage		Relevant to claims
X	US 4681653	(TEXAS) See esp col 3 line 1 - col 4 line 12 & Fig 3	1,2
X	US 4060660	(RCA) See esp col 2 line 48 - col 4 line 2 & Fig	1

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.